

Report as of FY2008 for 2008VT34B: "Tracing sources of eroded sediment with atmospherically produced ^{10}Be "

Publications

Project 2008VT34B has resulted in no reported publications as of FY2008.

Report Follows

Tracing sources of eroded sediment with atmospherically – produced 10-Be

Progress Report May 12, 2009

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Project motivation and objectives

Surface water bodies are under constant threat of environmental degradation such as accelerated nutrient loading that has been linked to anthropocentric activities. Phosphorous, which binds tightly to soil sediments, has been noted as the largest pollutant of lakes and waterways. Although some land management practices focus on mitigating sediment removal from stream banks and agricultural fields, currently there are no analytical methods to provide sediment source information on a basin wide scale. Such a system may be economically beneficial in developing strategic land management plans specific to individual watersheds. Due to these difficulties this research is focused on the potential use of Cosmogenic beryllium-10 (10-Be) as a sediment fingerprinting tool in post glacial Vermont. Cosmogenic 10-Be is a radio-active isotope that occurs naturally by spallation of nitrogen and oxygen in the earth's upper atmosphere; with a constant global precipitation rate. After deposition of 10-Be to the earth's surface it binds tightly to soil sediments, and is subsequently transported with soil sediments. Due to the testing facilities necessary to measure 10-Be concentrations this research also focuses on correlating 10-Be concentrations to other compounds that require less specialized testing facilities. The work is in progress and expected to finish by October 2009.

Approach

In order to evaluate the use of 10-Be for tracing sediment entering the Lake Champlain basin, the research approach is to collect and process suspended sediment samples from a suite



Figure 1. Image of Winooski river basin and section of Lamoille River basin showing suspended sediment sampling points.

of geomorphic/human impact settings. Samples are taken from three different high flow events, including the spring snow-melt during which the bulk of sediment transport occurs. Our testable hypotheses are: (1) 10-Be concentration in river-transported, fine-grain sediment reflects the 10-Be concentration in sediment sources weighted by the proportion of sediment derived from each source; and (2) sediment from different sources has different average concentrations of 10-Be.

Watersheds were selected in the Lake Champlain basin located in north western Vermont with five sampling sites located in the Winooski River basin, one

sub-watershed located in the Lamoille River basin, and one that flows directly into Lake Champlain (Figure 1). Care was taken to have a variable selection of stream sources that include

both upland and lowland streams that were located in forested and agricultural corridors: two in the main stem of the Winooski River, two upland streams, two lowland streams, and one impaired waterway located adjacent to Lake Champlain. Samples were also collected from agricultural fields and streambank material from several of the stream corridors. This distribution of samples was designed to allow us to estimate both the mean and spatial/temporal variability of ^{10}Be concentrations in fine grain sediment.

Progress

A custom sampling unit was developed to collect in-stream samples of sediments. This apparatus is composed of a compressed sieve stack with sieve increments of 53, 73, 125, 250, and 500 μm , allowing simultaneous collection of four grain size fractions. To date 21 sample sets have been collected from the selected stream points during high flow events. In order to test temporal variability of ^{10}Be , with minimal storm event influence, five sediment sample sets were collected at the mouth of the Winooski River during the spring melt. In addition to suspended sediment samples a series of samples have been collected from bank material and agricultural fields in the sample streams' corridors. All samples have been dehydrated and stored ready for the beryllium extraction process.

Future work

All sediment samples have now been collected and catalogued and are ready for beryllium extraction process prior to testing for ^{10}Be concentration at Lawrence Livermore National Laboratory. Future efforts will include correlating other sediment bound compounds specifically aluminum and ferric oxides to ^{10}Be concentrations. For that purpose a standardized citrate-bicarbonate-dithionite extraction will be performed on the larger of sediment samples collected. Concentrations of iron and aluminum oxides will then be measured using ICP mass spectrometry and compared to ^{10}Be concentrations.

Values collected from testing will yield concentrations of ^{10}Be , iron, and aluminum oxide compounds of the various grain size fractions for both the suspended sediment and corridor material samples. Each individual concentration will then be analyzed looking at the concentrations specific to each suspended sediment and corridor material grain size fraction, noting variations in the concentrations based on the stream type sampled and the grain size analyzed. Temporal variation will be observed during the spring melt event at the main stem of the Winooski River. Variation between the spring, summer, and fall sample sets will be calculated using a paired t-test statistical analysis. Results from these analyses will suggest if ^{10}Be has potential use for fingerprinting suspended sediments, and if sediment sources change during different types of flow events.

Student Training

Jaron Borg has been working on this project and this research is a part of his M.S. thesis. The PIs, Mandar Dewoolkar and Paul Bierman, have been meeting with Jaron regularly. A journal paper is anticipated once the research is concluded. Jaron made a presentation on this topic in Civil and Environmental Engineering seminar series.